ANTENNA DEVICE AND WIRELESS COMMUNICATION APPARATUS HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION(S) AND CLAIM OF PRIORITY

[0001] The present application is related to and claims the priority under 35 U.S.C. §119(a) of applications entitled "Antenna Device And Wireless Communication Apparatus Having The Same" filed in Japanese Patent Office on Nov. 12, 2009 and assigned Serial No. 2009-258646, Nov. 12, 2009 and assigned Serial No. 2009-258647, and filed in Korean Intellectual Property Office on Sep. 17, 2010 and assigned Serial No. 10-2010-0091687, the contents of which are hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention relates to an antenna device and a wireless communication apparatus having the same and, more particularly, to an antenna device used for a mobile communication terminal and a wireless communication apparatus having the same.

BACKGROUND OF THE INVENTION

[0003] A current wireless communication apparatus has a wireless communication function that corresponds to a plurality of wireless communication systems, and a small-sized antenna or an antenna that operates in a plurality of frequency bands or a wide range is required.

[0004] In an antenna device that operates in a plurality of frequency bands, a tunable antenna changes a frequency band. For example, in International Publication pamphlet No. 07/042,615, an adjustment circuit obtained by combining conductive lines with different lengths is installed at a power supply part of a monopole antenna, resulting in an antenna device that changes a frequency band. Furthermore, in JP-T-2009-510900, a selection circuit connected to a parasitic element of an antenna device is switched to change capacitive coupling with a monopole antenna, resulting in a change in a resonant frequency. In addition, an attempt has been made to achieve an antenna that operates in a wide band by using a SRR (Split Ring Resonator). Because the SRR has been known as an element of a meta-material and is a structure that exhibits material characteristics (negative permeability) that do not exist naturally, research has been conducted in order to obtain a magnetic response at a desired frequency. For example, in U.S. Pat. No. 6,970,137, wide band characteristics are achieved using a PIFA (Planar Inverted-F Antenna) obtained by inserting a dielectric including a plurality of SRRs therein between a ground conductor and an antenna conductor.

SUMMARY OF THE INVENTION

[0005] In the tunable antenna according to the conventional art, the conductive lines with the different lengths are switched using a switch, resulting in a change in a frequency band. However, conductive lines are required corresponding to the number of variable frequency bands. Therefore, when the number of variable frequency bands increases, because the structure of the antenna is increased, the antenna may not be fabricated in a small size. Furthermore, even when the selection circuit is connected to the parasitic element and switched using a switch, resulting in a change in a frequency band, when the number of variable frequency bands increases, because it is necessary to increase the number of parasitic elements, the antenna may not be fabricated in a small size due to the increase in the structure of the antenna.

[0006] To address the above-discussed deficiencies of the prior art, it is a primary object to provide an antenna device that can be fabricated in a small size without the increase in the structure thereof even if the number of frequency bands used increases, and can easily change a resonant frequency in a desired frequency band.

[0007] Also, in U.S. Pat. No. 6,970,137, because the plurality of SRRs are disposed in the dielectric block constituting the antenna, the structure thereof is complicated and the dielectric block may not be easily manufactured. Furthermore, because the plurality of SRRs are disposed in the dielectric block, it is difficult to adjust the length of each SRR, an interval among the SRRs and the like, and cost may increase in order to manufacture an antenna with desired performance. In addition, the SRR operates at a frequency at which the length of a conductor is close to half the wavelength. Therefore, when determining the material characteristics of the dielectric block or the dimensions of the SRR in the antenna configuration disclosed in U.S. Pat. No. 6,970,137, the SRR may not operate in a desired frequency band.

[0008] Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the prior art, and the present invention provides an antenna device and a wireless communication apparatus that can be fabricated in a small size by using material characteristics around the resonant frequency of the SRR, and can operate in a desired frequency band.

[0009] In accordance with an aspect of the present invention, an antenna device includes a dielectric that has a first and a second surfaces facing in substantially opposite directions. An inverted-L antenna is disposed at a side of the dielectric. A first conductive member forms a first loop that has a first gap. A planar side of the first loop is disposed facing the first surface of the dielectric. A second conductive member forms a second loop that has a second gap. A planar side of the second loop is disposed facing the second substantially planar surface of the dielectric. Each of the first and second conductive members includes a plurality of member components and a plurality of switches. And each of the plurality of switches are provided between two adjacent member components to allow the plurality of member components to be electrically conducted or cut off. According to the antenna device, in accordance with an embodiment of the present invention, a resonant frequency may be easily changed in a desired frequency band.

[0010] Furthermore, in the antenna device in accordance with an embodiment of the present invention, each of the first and second gaps may form an opening in the first and second loops of the first and second conductive members, respectively. A length of each of the first and second conductive members may form an inductance component. A size of the opening may form a capacitance component. The first and second conductive members may form an LC resonance circuit including the inductance component and the capacitance component. And the plurality of switches may allow the plurality of member components to be electrically conducted or cut off through an ON/OFF operation to change a number of connections, through which the plurality of member components are connected to each other, for each conductive member, resulting in a change in the inductance component of the